

Waveform Processing Airborne Laser Scanner for Wide Area Mapping and High Productivity

RIEGL VQ[®]-780 II-S

- **high laser pulse repetition rate up to 2 MHz**
- **up to 1.33 million measurements/sec on the ground**
- **excellent multiple target detection capability**
- **excellent suppression of atmospheric clutter**
- **Multiple-Time-Around (MTA) processing of up to 45 pulses simultaneously in the air**
- **online waveform processing as well as smart and full waveform recording**
- **parallel scan lines and uniform point distribution**
- **interface for GNSS time synchronization**
- **seamless integration and compatibility with other RIEGL ALS systems and software packages**

The *RIEGL VQ-780II-S* is a high performance, rugged, lightweight, and compact airborne mapping sensor. This versatile system is designed for high efficient data acquisition at low, mid, and high altitudes, covering a variety of different airborne laser scanning applications from high density to wide area mapping.

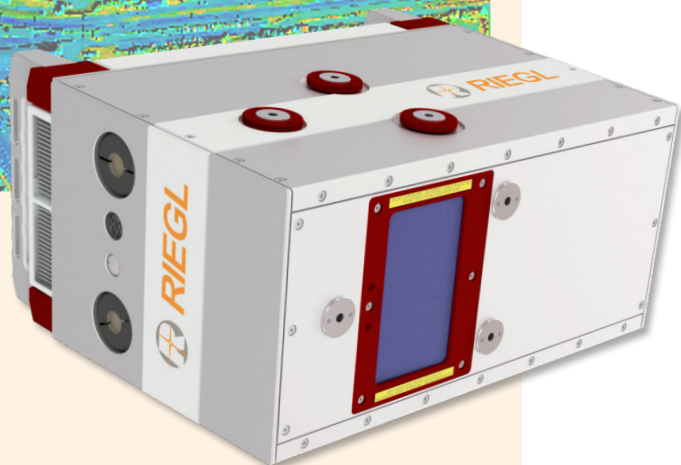
The high speed rotating mirror design ensures reliability, and uniform point distribution across its entire wide field of view and at all flight altitudes. Based on *RIEGL's* proven Waveform-LiDAR technology, the system provides point clouds with highest accuracy, excellent vertical target resolution, calibrated reflectance readings, and pulse shape deviation for unsurpassed information content on each single measurement. Excellent atmospheric clutter suppression yields clean point clouds with minimum efforts in filtering isolated noise points.

The system is complimented with *RIEGL's* advanced acquisition and data processing software suite that utilizes parallel computing (GPU) for fast data processing.

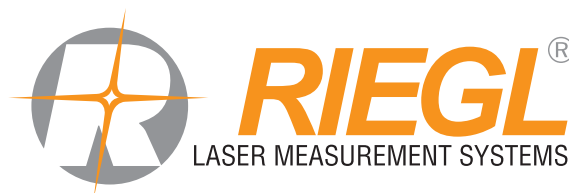
The *RIEGL VQ-780II-S* is designed to work with the latest Inertial Navigation (IMU) Systems, flight management systems, and camera options.

Applications:

- *Wide Area / High Altitude Mapping*
- *High Point Density Mapping*
- *Mapping of Complex Urban Environments*
- *Glacier & Snowfield Mapping*
- *City Modeling*
- *Mapping of Lakesides & River Banks*
- *Agriculture & Forestry*
- *Corridor Mapping*

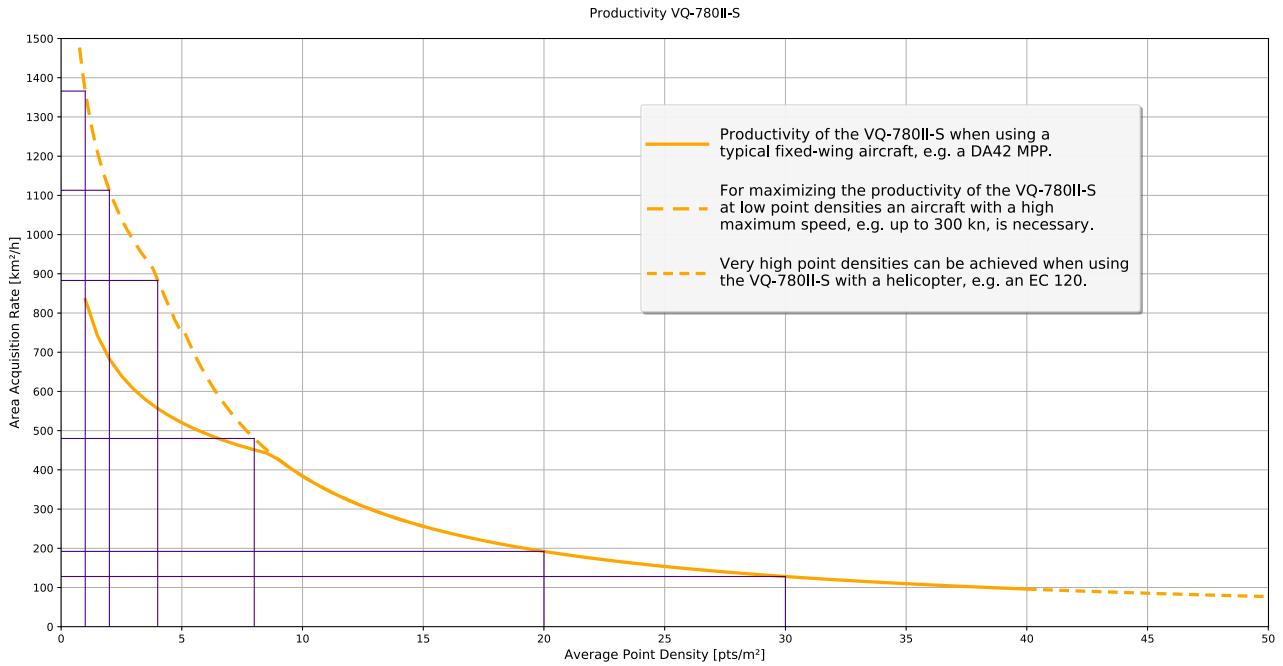


visit our website
www.riegl.com



RIEGL VQ®-780II-S Productivity

The RIEGL VQ-780II-S Airborne Laser Scanner offers highest productivity.



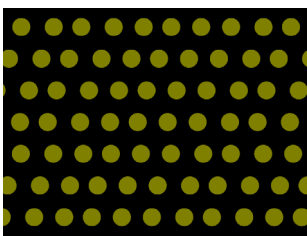
Examples ¹⁾

Average Point Density	1 pts/m ²	2 pts/m ²	4 pts/m ²	8 pts/m ²	20 pts/m ²	30 pts/m ²
Flight Altitude AGL	8730 ft 2660 m	7110 ft 2170 m	5810 ft 1770 m	4460 ft 1360 m	3720 ft 1130 m	2460 ft 750 m
Ground Speed	300 kn	300 kn	291 kn	206 kn	99 kn	100 kn
Swath Width	3070 m	2500 m	2050 m	1570 m	1310 m	870 m
Productivity	1366 km ² /h	1113 km ² /h	883 km ² /h	480 km ² /h	192 km ² /h	128 km ² /h
Measurement Rate ²⁾	474 000 meas./sec	773 000 meas./sec	1.23 mill. meas./sec	1.33 mill. meas./sec	1.33 mill. meas./sec	1.33 mill. meas./sec

¹⁾ calculated for 20% target reflectivity and 20% stripe overlap

²⁾ The target detection rate is equal to the measurement rate for terrains offering only one target per laser pulse but may be much higher for vegetated areas.

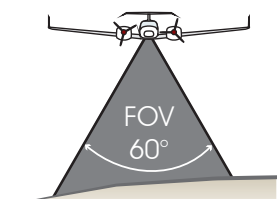
RIEGL VQ®-780II-S Dense Scan Pattern and Wide Effective Swath Width



RIEGL VQ-780II-S point distribution

The RIEGL VQ-780II-S scanning mechanism – based on a continuously rotating polygon mirror wheel – delivers straight parallel scan lines resulting in a regular point pattern on the ground. With equal spatial sampling frequency along and across track, object extents are well defined and even small objects may be detected. The instrument is perfectly suited for applications where a superior point pattern on target surfaces is required.

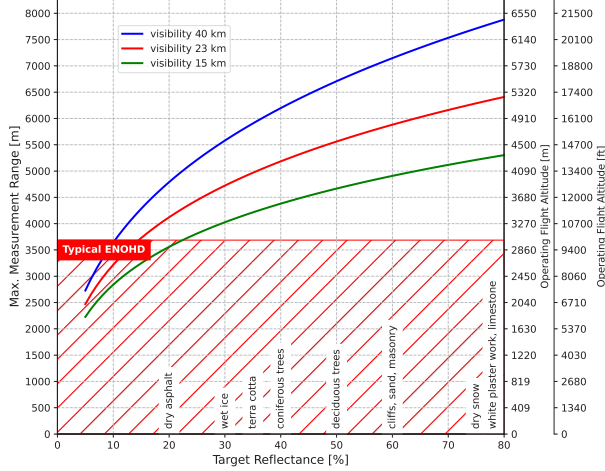
The wide field of view and the multiple-time-around (MTA) measurement capability of the RIEGL VQ-780II-S make the instrument perfectly suited for wide area mapping applications. The instrument has been designed for utmost efficiency in collecting data by enabling scanning operations from high altitudes at high laser pulse repetition rates simultaneously, reducing the necessary flight time to a minimum.



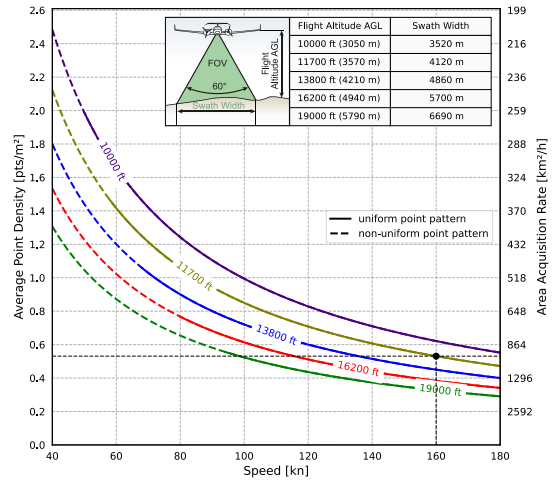
broad effective swath width

Measurement Range & Point Density RIEGL VQ®-780II-S

Laser Pulse Repetition Rate = 270kHz, laser power level 100%

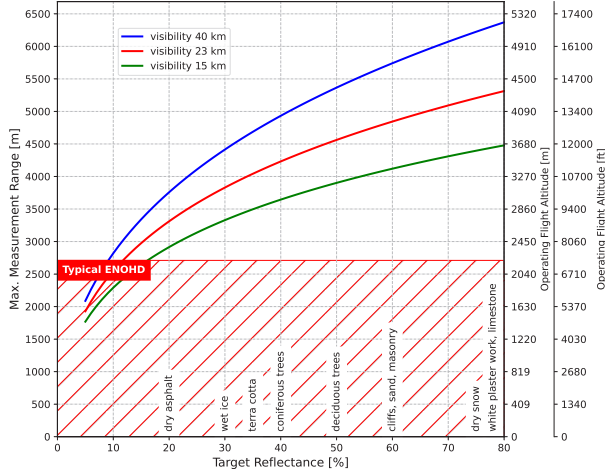


Example: VQ-780II-S at 270,000 pulses/sec, laser power level 100%
Altitude = 11,700 ft AGL, Speed 160 kn

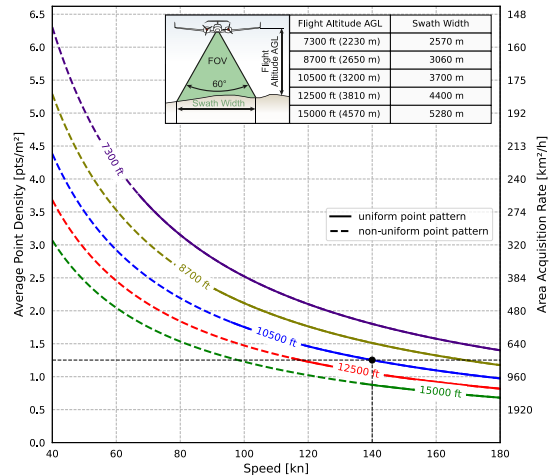


Results: Point Density ~ 0.53 pts/m²
Area Acquisition Rate ~ 976 km²/h

Laser Pulse Repetition Rate = 500kHz, laser power level 100%

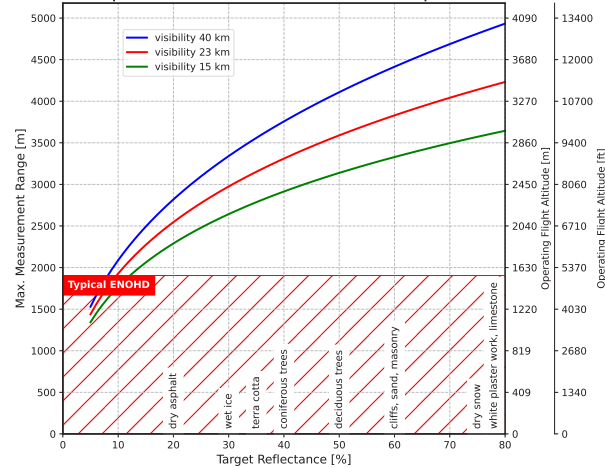


Example: VQ-780II-S at 500,000 pulses/sec, laser power level 100%
Altitude = 10,500 ft AGL, Speed 140 kn

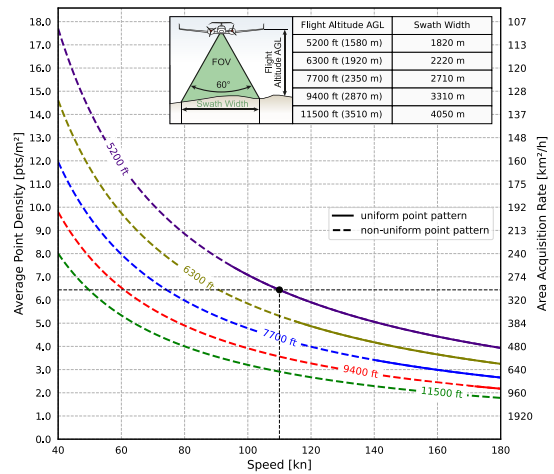


Results: Point Density ~ 1.25 pts/m²
Area Acquisition Rate ~ 767 km²/h

Laser Pulse Repetition Rate = 1000kHz, laser power level 100%



Example: VQ-780II-S at 1,000,000 pulses/sec, laser power level 100%
Altitude = 5,200 ft AGL, Speed 110 kn



Results: Point Density ~ 6.44 pts/m²
Area Acquisition Rate ~ 298 km²/h

The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

Assumptions for calculation of the Area Acquisition Rate

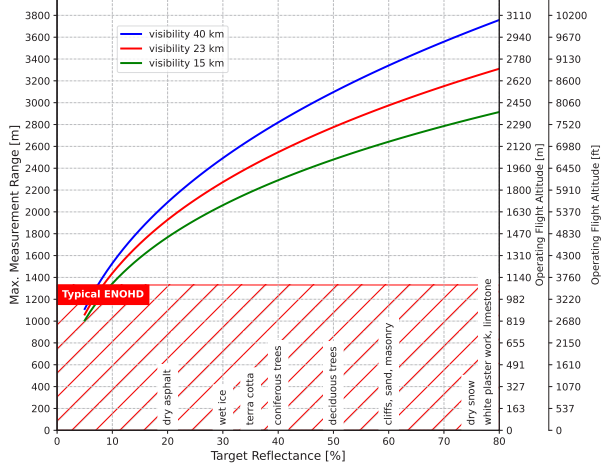
- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

Typical ENOHD

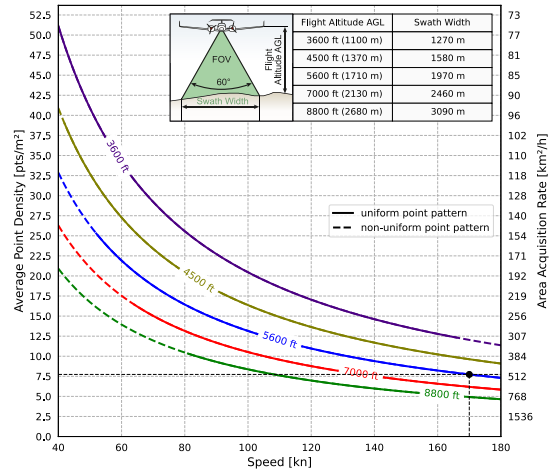
- Calculated under assumption of an angular step width of 0.012° and an aircraft speed higher than 10kn.

Measurement Range & Point Density RIEGL VQ[®]-780II-S

Laser Pulse Repetition Rate = 2000kHz, laser power level 100%

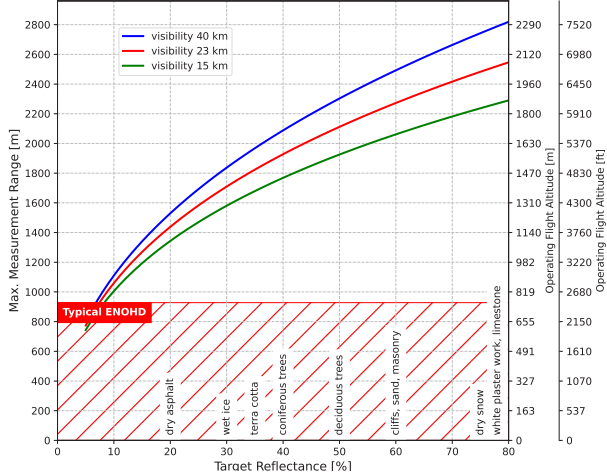


Example: VQ-780II-S at 2,000,000 pulses/sec, laser power level 100%
Altitude = 5,600 ft AGL, Speed 170 kn

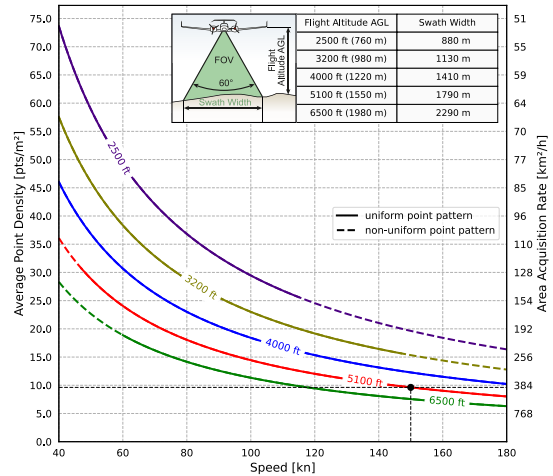


Results: Point Density ~ 7.74 pts/m²
Area Acquisition Rate ~ 496 km²/h

Laser Pulse Repetition Rate = 2000kHz, laser power level 50%

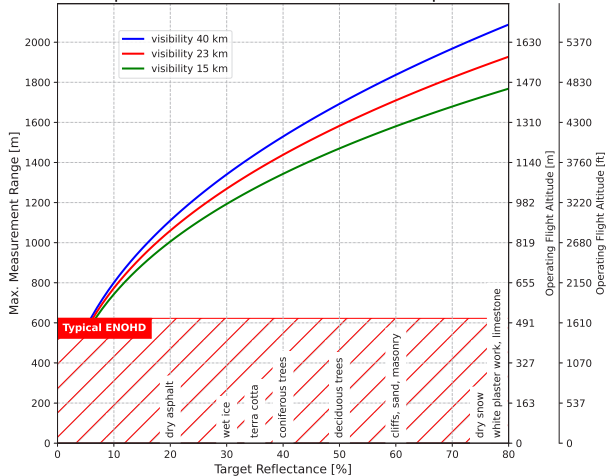


Example: VQ-780II-S at 2,000,000 pulses/sec, laser power level 50%
Altitude = 5,100 ft AGL, Speed 150 kn

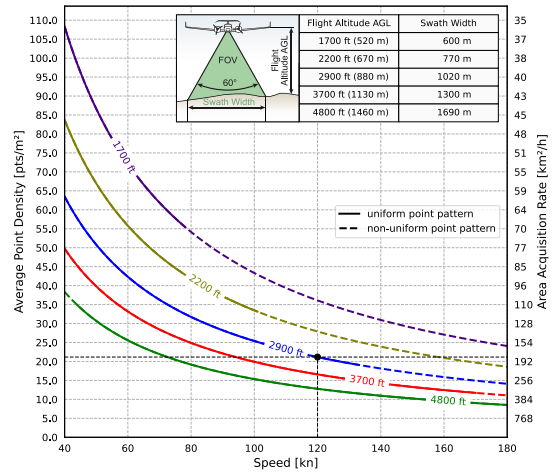


Results: Point Density ~ 9.63 pts/m²
Area Acquisition Rate ~ 399 km²/h

Laser Pulse Repetition Rate = 2000kHz, laser power level 25%



Example: VQ-780II-S at 2,000,000 pulses/sec, laser power level 25%
Altitude = 2,900 ft AGL, Speed 120 kn



Results: Point Density ~ 21.16 pts/m²
Area Acquisition Rate ~ 181 km²/h

The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

Assumptions for calculation of the Area Acquisition Rate

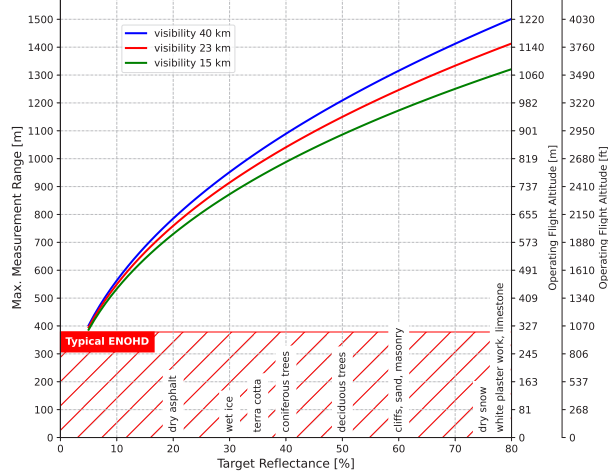
- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

Typical ENOHD

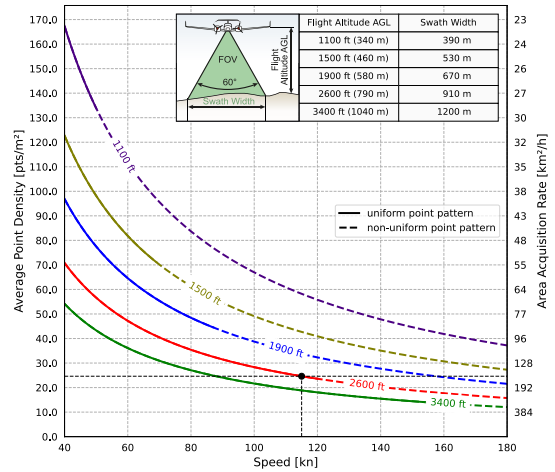
- Calculated under assumption of an angular step width of 0.012° and an aircraft speed higher than 10kn.

Measurement Range & Point Density RIEGL VQ®-780II-S

Laser Pulse Repetition Rate = 2000kHz, laser power level 12%

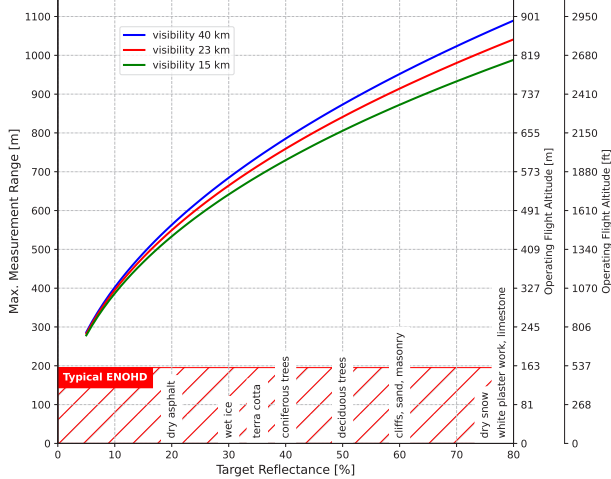


Example: VQ-780II-S at 2,000,000 pulses/sec, laser power level 12%
 Altitude = 2,600 ft AGL, Speed 115 kn

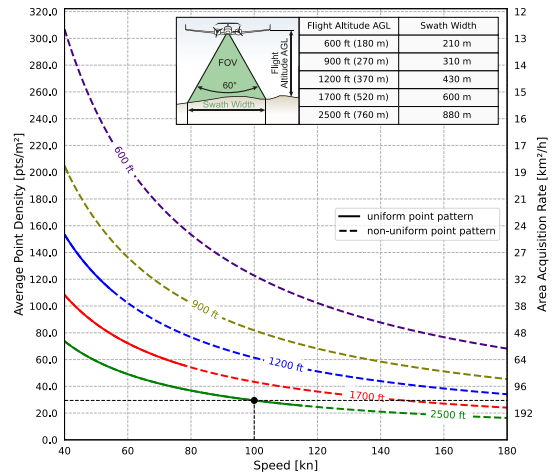


Results: Point Density ~ 24.63 pts/m²
 Area Acquisition Rate ~ 156 km²/h

Laser Pulse Repetition Rate = 2000kHz, laser power level 6%



Example: VQ-780II-S at 2,000,000 pulses/sec, laser power level 6%
 Altitude = 2,500 ft AGL, Speed 100 kn



Results: Point Density ~ 29.46 pts/m²
 Area Acquisition Rate ~ 130 km²/h

The following conditions are assumed for the Operating Flight Altitude AGL

- ambiguity resolved by multiple-time-around (MTA) processing
- target size ≥ laser footprint
- full FOV of 60°
- average ambient brightness
- roll angle ±5°

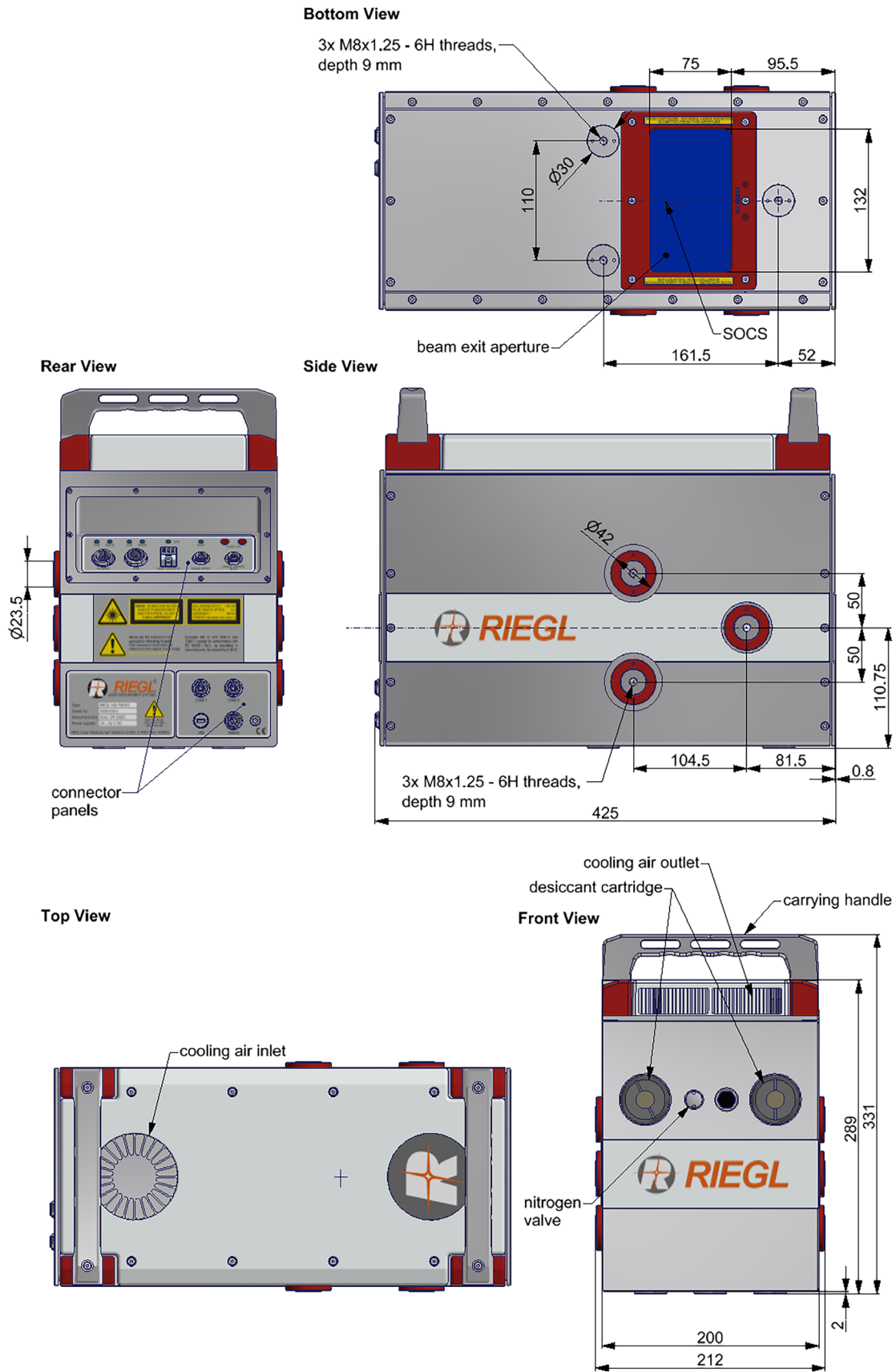
Assumptions for calculation of the Area Acquisition Rate

- 20% overlap of neighboring flight strips. This overlap covers a roll angle of ±5° or a reduction of flight altitude AGL of 20%.

Typical ENOHD

- Calculated under assumption of an angular step width of 0.012° and an aircraft speed higher than 10kn.

RIEGL VQ®-780II-S Main Dimensions

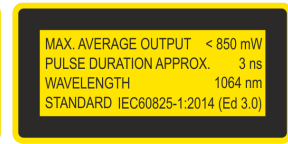


all dimensions in mm

Laser Product Classification

Class 4 Laser Product according to IEC60825-1:2014
The following clause applies for instruments delivered into the United States: Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed.3., as described in Laser Notice No. 56, dated May 8, 2019.

The instrument must be used only in combination with the appropriate laser safety box.



Range Measurement Performance

as a function of laser power setting, PRR, and target reflectivity

Laser Power Level	100%			
Laser Pulse Repetition Rate (PRR) ¹⁾	270 kHz	500 kHz	1000 kHz	2000 kHz
Max. Measuring Range ^{2) 3) 4)} natural targets $\rho \geq 20\%$ natural targets $\rho \geq 60\%$	4800 m 7100 m	3700 m 5600 m	2800 m 4300 m	2050 m 3300 m
Max. Operating Flight Altitude Above Ground Level ^{2) 5)} natural targets $\rho \geq 20\%$ natural targets $\rho \geq 60\%$	3900 m 12800 ft 5800 m 19000 ft	3000 m 10000 ft 4600 m 15000 ft	2200 m 7500 ft 3500 m 11500 ft	1700 m 5500 ft 2700 m 8800 ft
NOHD ^{6) 8)} ENOHD ^{7) 8)}	430 m 3020 m	310 m 2220 m	220 m 1560 m	155 m 1090 m
Max. Number of Targets per Pulse ⁹⁾	14	14	9	4

Laser Power Level	50%	25%	12%	6%
Laser Pulse Repetition Rate (PRR) ¹⁾	2000 kHz	2000 kHz	2000 kHz	2000 kHz
Max. Measuring Range ^{2) 3) 4)} natural targets $\rho \geq 20\%$ natural targets $\rho \geq 60\%$	1500 m 2450 m	1100 m 1800 m	780 m 1300 m	560 m 940 m
Max. Operating Flight Altitude Above Ground Level ^{2) 5)} natural targets $\rho \geq 20\%$ natural targets $\rho \geq 60\%$	1200 m 4100 ft 2000 m 6500 ft	900 m 2900 ft 1450 m 4800 ft	630 m 2100 ft 1050 m 3400 ft	450 m 1500 ft 760 m 2500 ft
NOHD ^{6) 8)} ENOHD ^{7) 8)}	105 m 760 m	67 m 510 m	38 m 310 m	22 m 160 m
Max. Number of Targets per Pulse ⁹⁾	4	4	4	4

- 1) rounded average PRR
- 2) Typical values for average conditions and average ambient brightness; in bright sunlight the operational range may be considerably shorter and the operational flight altitude may be considerably lower than under an overcast sky.
- 3) The maximum range is specified for flat targets with size in excess of the laser beam diameter, perpendicular angle of incidence, and for atmospheric visibility of 40 km. Range ambiguities have to be resolved by multiple-time-around processing.
- 4) If the laser beam hits, in part, more than one target, the laser's pulse power is split accordingly. Thus, the achievable range is reduced.
- 5) Typical values for max. effective FOV 60°, additional roll angle $\pm 5^\circ$
- 6) Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition.
- 7) Extended Nominal Ocular Hazard Distance, based upon MPE according to IEC 60825-1:2014, for single line condition.
- 8) NOHD and ENOHD have been calculated for a typical angular step width of 0.012° (which means non-overlapping laser footprints), and an aircraft speed higher than 10 kn. NOHD and ENOHD increase when using overlapping laser footprints which may be intended e.g. for power line mapping.
- 9) when using online waveform processing

Minimum Range ¹⁰⁾

Accuracy ^{11) 12)}

Precision ^{12) 13)}

Laser Pulse Repetition Rate ¹⁹⁾

Effective Measurement Rate

Echo Signal Intensity

Laser Wavelength

Laser Beam Divergence

100 m

20 mm

20 mm

270 kHz up to 2 MHz, selectable in steps of less than 1%

up to 1333 kHz @ 60° scan angle

provided for each echo signal

near infrared

typ. 0.17 mrad @ 1/e ¹⁴⁾, typ. 0.23 mrad @ 1/e² ¹⁵⁾

Scanner Performance

Scanning Mechanism

Scan Pattern

Scan Angle Range

Total Scan Rate

Angular Step Width $\Delta\theta$

Angle Measurement Resolution

rotating polygon mirror

parallel scan lines

$\pm 30^\circ = 60^\circ$

20 ¹⁶⁾ - 300 lines/sec

$0.006^\circ \leq \Delta\theta \leq 0.100^\circ$ ^{17) 18)}

0.001°

10) Limitation for range measurement capability, does not consider laser safety issues! The minimum range for valid reflectivity values is 250 m.

11) Accuracy is the degree of conformity of a measured quantity to its actual (true) value.

12) Standard deviation one sigma @ 250 m range under RIEGL test conditions.

13) Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.

14) Measured at the 1/e points. 0.17 mrad correspond to an increase of 17 cm of beam diameter per 1000 m distance.

15) Measured at the 1/e² points. 0.23 mrad correspond to an increase of 23 cm of beam diameter per 1000 m distance.

16) The minimum scan rate depends on the selected laser PRR.

17) The minimum angular step width depends on the selected laser PRR.

18) The maximum angular step width is limited by the maximum scan rate.

19) For smart and full waveform recording the max. laser PRR is limited to 1600kHz.

Technical Data to be continued at page 8

Technical Data *RIEGL VQ®-780II-S (continued)*

Data Interfaces

Configuration
Monitoring Data Output
Digitized Data Output
Synchronization

TCP/IP Ethernet (10/100/1000 MBit/s)
TCP/IP Ethernet (10/100/1000 MBit/s)
High-speed data link to *RIEGL* Data Recorder DR1560ii
Serial RS-232 interface, TTL input for 1 pps synchronization pulse,
accepts different data formats for GNSS-time information
2 x power, RS-232, 1 pps, trigger, exposure

Camera interface

General Technical Data

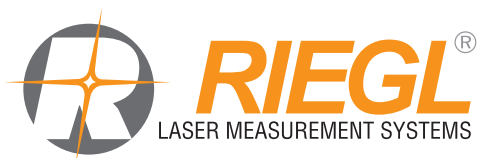
Power Supply / Power Consumption
Main Dimensions (length x width x height)
Weight

18 - 32 V DC / typ. 220 W
425 mm x 212 mm x 331 mm
approx. 20 kg

Protection Class
Max. Flight Altitude operating / not operating
Temperature Range operation / storage

IP54
18500 ft (5600 m) above MSL¹⁾ / 18500 ft (5600 m) above MSL
-5°C up to +35°C / -10°C up to +50°C

1) Mean Sea Level



RIEGL Laser Measurement Systems GmbH
Horn, Austria
Phone: +43 2982 4211 | www.riegl.com
RIEGL USA Inc.
Winter Garden, Florida, USA
Phone: +1 407 248 9927 | www.rieglusa.com

RIEGL Japan Ltd. | www.riegl-japan.co.jp
RIEGL China Ltd. | www.riegl.cn
RIEGL Australia Pty Ltd. | www.riegl.com
RIEGL Canada Inc. | www.rieglcanada.com
RIEGL UK Ltd. | www.riegl.co.uk

www.riegl.com